

Pre-concentration & Measurement of Low Levels of Gamma-Ray Emitting Radioisotopes in Coastal Waters

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Abstract

We have developed a large-volume, high-speed water sampler for the concentration and measurement of radionuclides in coastal water environments by high-resolution gamma ray spectrometry. The sampler allows the processing of hundreds to thousands of liters of natural waters at rates of 10-20 L/min, and provides for the investigation of the distribution behaviors of radioisotopes into suspended particle-bound and dissolved chemical species. The present technique involves the pre-concentration of radionuclides using physical filtration methods for suspended matter and inorganic composite sorbents for dissolved species. The operational performance and extraction efficiencies for several test radioisotopes of the sampler have been assessed both in the laboratory and in actual field testing with river and seawater samples. Extraction and recovery efficiencies of better than 90% for most fission and activation product radioisotopes have been observed. Application of the present technique to the analysis of femtoCurie-to-sub-femtoCurie-per-liter concentrations of Cs-137 in the aquatic environment is discussed.

Adaptation of an electromechanically-cooled high-resolution germanium gamma-ray spectrometer with the large-volume, high-speed water sampler allows for at-sea detection of low-level concentrations of radionuclides in the marine environment. The use of a robust, low-maintenance Stirling cryocooler device for cooling the detector to liquid nitrogen (LN₂) temperatures and the application of an active electronic vibration suppression mechanism provides for near LN₂-cooled performance without significant deterioration of energy resolution. This set up obviates the need for a constant supply of LN₂, hence allowing for operations in remote or inaccessible areas for extended periods. Preliminary at-sea measurements will be presented.

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